SLOPE: An Effort towards Infusing Service -Learning into Physics and Engineering Education

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ABSTRACT
The acronym SLOPE - "Service Learning Opportunities in Physics and Engineering" has provided an umbrella for infusing "Service-Learning" seamlessly into a recently articulated collaborative engineering program among UMES (University of Maryland Eastern Shore) a Historically Black College and University (HBCU), SSU (Salisbury State University) and the University of Maryland College Park(UMCP). The agreement provides a means of bringing an ABET accredited engineering degree program from the prestigious Clark School of Engineering at College Park to the residents of Eastern Shore region of the State of Maryland. Since its inception in the fall of 1998, the SLOPE program has helped identify and serve specific needs in the Eastern Shore Community by way of faculty supervised student projects. These student projects have been chosen either by the student/student group or assigned by the faculty. In all cases the faculty members involved with the program have ensured compatibility with course material and desired learning objectives. Specific attention has been paid to the Engineering Criteria 2000 of ABET in developing the activities of the SLOPE program. Experiential learning integrated with community service has provided a means for the students to "learn" as they "serve". It has provided the foundation for a symbiotic win-win relationship between the student and the community. It is quite early to predict the impact of these activities on the retention and performance of students in Physics and Engineering disciplines. However, early indications suggest that involvement in the university, community, local high schools and within their own families via "Service-Learning" projects will significantly improve the possibility of retaining the students in the university till the award of their degrees.

I. Introduction

With the approach of the new millennium and the emergence of the global market, significant restructuring of university education in general, and Science and Engineering education in particular[1] is taking place with the objective of preparing the students for the new social and economic order.

Many academic leaders agree that some of the general qualities that a university student must imbibe to integrate effectively in the social order of the new millennium are to be able to work effectively in teams; to develop a moral center; to be able to work and serve in a global context; to have the ability to integrate knowledge from many different fields; to be able to appreciate complexity; to be capable of working in a variety of interpersonal and organizational settings; to be able to act reflectively.

Engineering is a profession in which knowledge of mathematical and natural sciences acquired by study, experience and practice is prudently applied to develop ways to utilize optimally materials and forces of nature for the benefit of mankind and improving quality of life. "Service-Learning" is a combination of academic instruction with service that addresses real community needs. It uses reflection and critical thinking to provide an emphasis on personal growth and civic responsibility. Humanities and Social Sciences curricula emphasize more on "soft skills" and "social service" and as such have naturally embraced "Service-Learning"[2-5]. Integration of "Service-Learning" within academic disciplines that emphasize on "technical" and "scientific" skills such as Engineering and Physics are rare. References [6-8] are among the very few reported endeavors. The emerging trends in "outcome" based engineering education facilitated by Engineering Criteria 2000 (EC2000) developed by the Accreditation Board of Engineering and Technology (ABET) demands a holistic blend of "soft" and "technical" skills. It also calls for a synchronized effort among faculty, staff and administration to incorporate a continuous improvement cycle in academia. Figure 1 shows the " Continuous Improvement Cycle in EC 2000 ". As illustrated in the figure, EC2000 consists of two loops. The first loop helps establish the educational objectives by surveying the constituency. The second loop compares the educational objectives set up by the first loop with the outcomes that result from the academic process. The assessment of the outcomes is integrated within the academic process. The differences observed between the outcomes and objectives help refine the academic process or the objectives or both, such that they become compatible with one another. This helps to set up a continuous improvement cycle. Typically frequency of the loop closure is faster for the second loop rather than for the first loop. Implementation of "Service-Learning" in a novel and creative fashion may well provide an effective pedagogical tool consistent with this new paradigm. It not only provides a vehicle to integrate the well-documented benefits of "Experiential-Learning Cycle" [9] within academic course work but also provides a direct method of addressing some of the needs of the constituency in the academic process. A flowchart of the "Experiential Learning Cycle" is shown in Figure 2.

II. Infusing Service-Learning into Engineering and Physics Courses

“Service-Learning”, as observed in reference[10] provides a win/win/win situation where the winners are the community, students and the university. As such while infusing Service-Learning into the Engineering Program, care has been taken to ensure benefits not only to the community and the students but also to promote the universities and their public image.

The activities of the SLOPE program provide the following services to the local community:

(i) Improved awareness of Physics/Engineering education and its objectives and impact on the Eastern Shore Community and high school students.

(ii) Student projects in partnerships with local community service organizations.
(iii) Development of teaching aids for classes and laboratories in local schools.

"Service-Learning" has been introduced in selected Engineering and Physics courses. The standard format involving preparation, action and reflection have been incorporated [11]. Student projects that address community needs that dovetail with the 'learning objectives and outcomes' of the selected courses are only encouraged. Currently, "Service-Learning" has been infused into the following courses within the Engineering and Physics curricula:
a. Introduction to Engineering (ENES 100)
b. Programming Concepts for Engineers (ENEE 114)
c. Statics (ENES 102)
d. Integrated Science (SCIE 110)
e. Physics I (PHYS 221)

A 10% to 20% of the grade has been assigned to "Service-Learning" activities in all of these courses. Student/Team responsibilities for service learning projects are as follows:

- Identification of an activity in consultation with the faculty
- Identification of a contact person at the site where the "service" will be provided
- Development of a questionnaire for evaluating the usefulness of the activity
- Arrangement of the time(s) and date(s) of activity/presentation(s) with the contact person identified.
- Reflection on the activity and its learning outcomes by way of a written report which must also include a survey based on the questionnaire prepared, as well as a letter from the contact person to the instructor based on the activity performed.

III. Highlights of some of the Important Activities

Engineering students have given seminars to high school students that aided in the improvement of their knowledge in computer programming, web page development, and computer architecture. Some of the students have performed educational activities in their own families. Participation and involvement of family members have elevated the students motivation and desire to excel. Students have also solved network problems at some local high schools and discussed networking issues with high school groups.

Initiated by the faculty members, Engineering and Physics students have formed partnerships with two local community based non-profit organizations:

- EXCEL - Extra Curricular Laboratories Inc., an interactive science museum with exhibits, that make science learning fun for all ages through hands on activities and mentoring;
- Holly Foundation a non-profit organization involved in rehabilitation support services that include development of adaptive equipment and assistive technology for disabled individuals.

At EXCEL the students are developing computer and web based demonstration of some of the exhibits. Some efforts have been devoted to developing new exhibits.

Members from Holly Foundation have introduced to the engineering students at UMES and SSU, by way of a invited guest lecture, the nature of medical engineering and assistive technology related design work they perform. These efforts are geared towards improving quality of life of disabled individuals. Students are participating in some of the brainstorming sessions at the foundation to design and develop innovative products related to adaptive equipment and recreational programming. Some of these ideas will be implemented in engineering design projects at the freshman and sophomore level.

A design project titled "Teaching Tools for Teachers" have been implemented at a local high school by an engineering student [12]. The project visually reinforces some of the mathematical and scientific concepts pertaining to Engineering Mechanics and provides a platform for introducing engineering design to high school students.

Freshman engineering students are also giving presentations related to their freshman level design projects, to local high schools. This activity has not only improved the general awareness of engineering and physics education, its benefit and socio-economic impact in the local community but has also impacted recruitment efforts significantly.

Sophomore Education majors are being encouraged to be involved with local middle schools for their Service-Learning project. The activity is being designed to prepare them for their future teaching career in Elementary and Middle schools.

IV. Learning Outcomes

"Service-Learning" emphasizes both "Service" and Learning" and can be distinguished from activities that may be labeled as "Volunteerism" or "Community Service", where the "Learning" aspect is insignificant. Students "Learn" as they "Serve" their community. Therefore, it is important to identify and encourage activities that have specific learning outcomes consistent with course and curricula within which such activities are performed. In the category of the academic outcomes, "Bloom's Taxonomy of Educational Objectives in the Cognitive Domain" was found to be extremely useful[13].

The learning outcomes that have been identified and emphasized in the SLOPE activities are:

- Improved presentation and communication skills,
- Better comprehension of course material to be able to relate to community groups and school students,
- Improved ability to work in teams and resolve conflicts,
- Understanding the "role" of customer in defining engineering projects,
- Better appreciation of engineering and its socio-economic impact,
- Increased awareness of the role of community service in society,
- Improved social interaction skills,
- Assimilation of skills and knowledge from many different fields,
- Inner/emotional growth as an individual and a citizen while helping others.

These outcomes are consistent with the philosophy behind the engineering curricula. Integration of "Service-Learning" provides a richer flavor and broader dimensions to the learning outcomes,

which include not only academic outcomes but also civic responsibility and life-skills outcomes as well [14]. Students involved in "Service-Learning" have reflected by way of interviews with the faculty as well as written reports that the activities have helped them in putting the knowledge they acquired in classrooms in perspective.

V. Conclusion

SLOPE activities have definitely gone a long way towards generating interest and excitement among engineering and physics students. Criteria 2000 of ABET calls for restructuring of engineering education and focuses emphasis on "learning outcomes" over and above "learning inputs" provided by faculty and university environment. SLOPE activities integrate well with the new paradigm of "outcome based" education. The activities provide avenues for students to show their abilities and skills in areas that may not be appropriately reflected in "tests" and "quizzes", thereby, improving the possibility of retaining students who may be poor "test-takers".

However, "retention" like "quality" is a function of many variables. Improved "retention" is a manifestation of improved "quality". Quality of incoming freshmen, university facilities and environment, faculty input, advising and counseling services are among the most important factors that affect retention. While activities such as the ones performed under SLOPE improve retention possibilities of motivated students and enhances academic quality, they will have a stronger impact as they get integrated with other quality improvement efforts by the administration, staff, and faculty in concert with the continuous improvement cycle advocated by EC2000.

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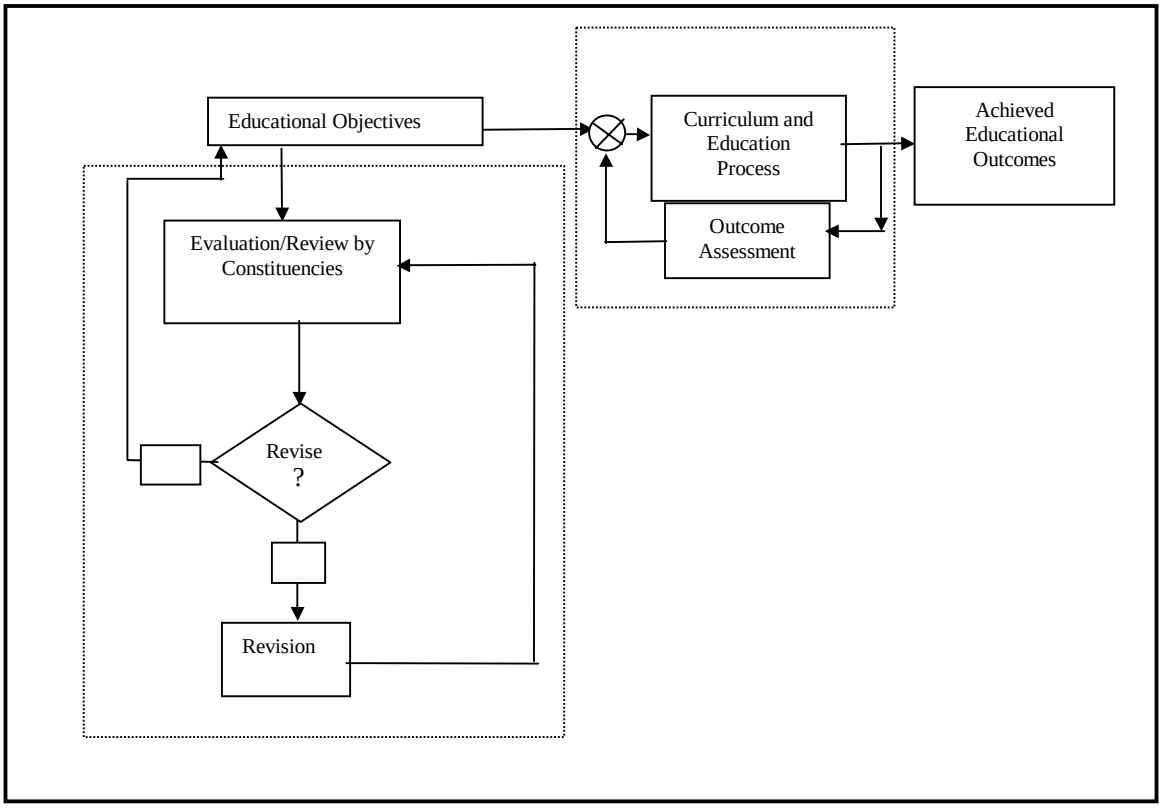

Figure 1 : Continuous Improvement Cycle in EC 2000

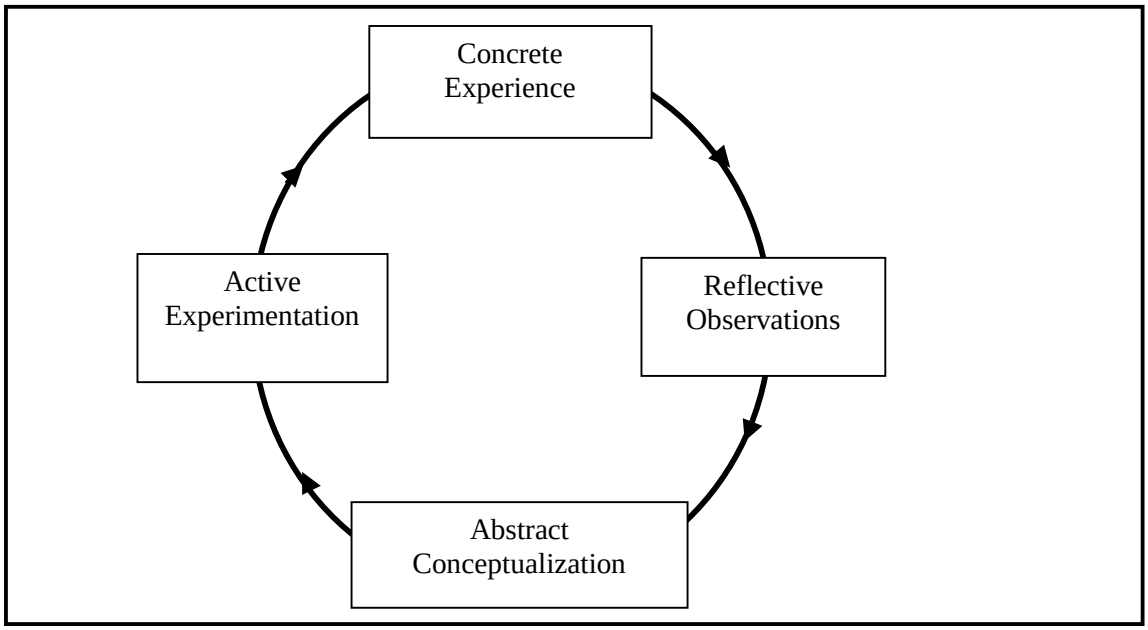

Figure 2 : Experiential Learning Cycle